

Takashi MIKAWA*: A taxonomic study on Japanese
sporangiferous Mucorales. (4)**

三川 隆*: 日本産胞子嚢性ケカビ目菌類の分類学的研究 (4)**

Helicostylum Corda, Icon. Fung. 5: 18 (1842).

Haynaldia Schulzer, Verh. Zool. Bot. Ges. Wien 17: 37 (1866)—*Bulbothamnidium* Klein, ibid. 20: 557 (1870)—*Chaetosylum* van Tieg. et Le Monn. Ann. Sci. Nat. Bot. V, 17: 328 (1873).

Rhizoids and stolons absent. Sporangiphores arising from substrate mycelia, ending into a terminal sporangium or a sterile spine. Sporangia globose, without apophyses. Branchlets of sporangiola arising singly or in whorls from main sporangiophores, either unbranched, ending into sporangiola or repeatedly branched in whorls; its branchlets ending into sporangiola or sterile spines, straight or recurved. Sporangiola globose. Zygospores unknown.

Type species: *Helicostylum elegans* Corda.

Traditionally *Helicostylum* has been distinguished from *Chaetostylum* by the following feature; the former has circinate branchlets of sporangiola, whereas the latter has straight ones. However, in 1958 Lythgoe found the intermediate form between *Helicostylum* and *Chaetostylum*, producing straight ones together with circinate branchlets of sporangiola, and reduced *Chaetostylum* to a synonym of *Helicostylum*. Lythgoe's view was supported by Upadhyay (1973).

von Arx & Upadhyay (1970) pointed out that several species of *Helicostylum* differed from the type species of genus, *Helicostylum* in having rhizoids and stolons, apophysate terminal sporangia, and usually pyriform sporangiola. The former was classified in a separate genus, *Thamnostylum* von Arx et Upadhyay. This treatment has been accepted by many mycologists including Upadhyay (1973) and Benny & Benjamin (1975).

Three species have been hitherto known, in which only one species has

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been found in Japan.

Helicostylum fresenii (van Tieg. et Le Monn.) Lythgoe, Trans. Brit. Mycol. Soc. 41: 139 (1958).

Ascophora pulchra Preuss, Linnaea 24: 139 (1851)—*Bulbothamnidium elegans* Klein, Verh. Zool. Bot. Ges. Wien 20: 577 (1870)—*Chaetostylum fresenii* van Tieg. et Le Monn., Ann. Sci. Nat. Bot. V, 17: 329 (1873)—*Thamnidium chaetocladioides* Brefeld, Bot. Unters. Schimmelpilze 4: 58 (1881)—*T. fresenii* (van Tieg. et Le Monn.) Schroeter, in Cohn's Krypt. Schles. 3: 210 (1886)—*Chaetostylum echinatum* Sorokin, Rev. Mycol. 11: 141 (1889)—*Bulbothamnidium pulchrum* (Preuss) Sumstine, Mycologia 2: 144 (1910)—*B. pulchrum* var. *variable* Sumstine, ibid. 2: 144 (1910)—*Chaetostylum fresenii* var. *macrosporum* Naumov, Clés des Mucorinées 60 (1939).

Illust.: Indoh, H. 1962. figs. 1, a-f; fig. 3.

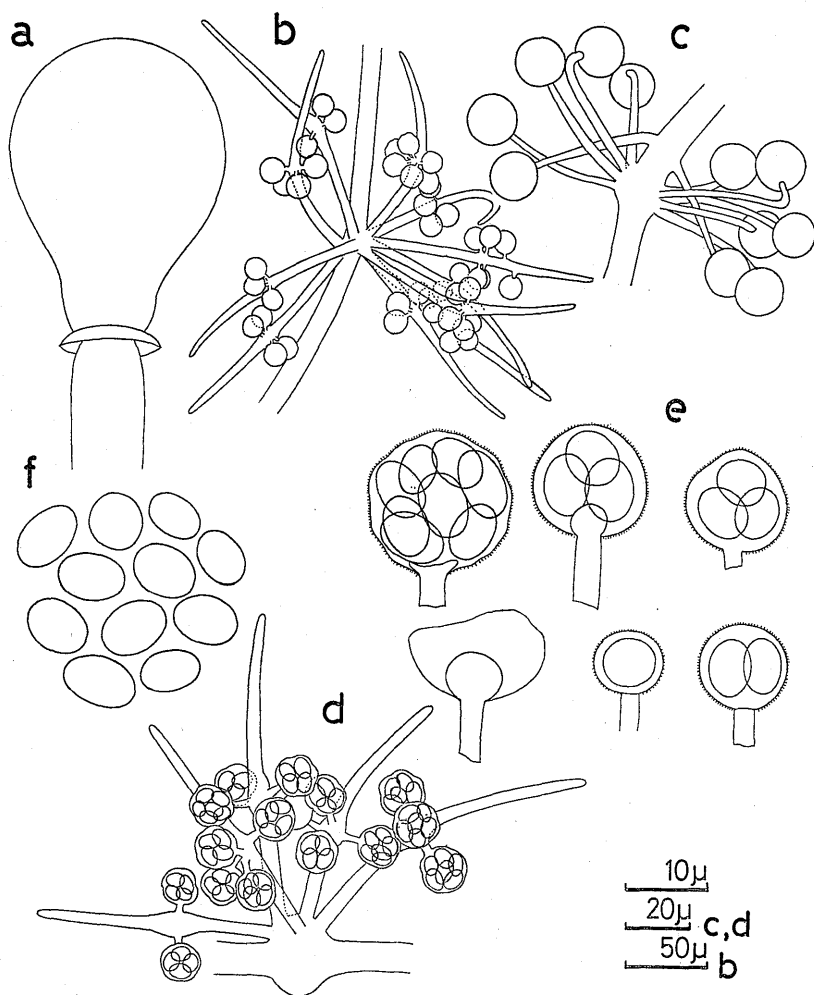
Colonies on LCA incubated at 20°C for a week light olive-gray to light brownish-gray, 1.5 cm high. Vegetative hyphae up to 27 μ m wide, hyaline. Gemmae not observed. Sporangioophores 9.2–41.5 μ m wide, hyaline, septate, unbranched or branched sympodially. Sporangia 50–125 μ m in diam., yellowish-brown. Sporangial walls hyaline, spiny. Columellae pyriform to ob-ovoid, 31.5–97 μ m long, 22.6–75.3 μ m wide, hyaline, smooth, with a collar, constricted at the base. Branchlets of sporangiola and sterile spines arising singly or in whorls from main sporangioophores, ending into sporangiola or whorls of secondary or tertiary branchlets; the central axis of each whorl slightly tapered towards the apex, 6–10.8 μ m wide, ending into a sterile spines, not recurved. Sporangiola 13.9–23.9 μ m in diam., yellowish-brown, with or without columellae. Sporangiolar walls hyaline, roughened, persistent. Sporangiospores from sporangia and sporangiola ovoid to ellipsoid, 8–10.3 \times 5.3–6.8 μ m, hyaline to pale yellow. Zygospores unknown.

Hab. and Loc. coll.: from rat dung, Nishiokoppe, Hokkaido (Mikawa-no. 567); rat dung, Sapporo, Hokkaido (Mikawa-no 445); refrigerated beef, Tokyo (Indoh, 1962 as *Chaetostylum fresenii* van Tieg. et Le Monn.)

The present isolates agreed well with the original description and the description given by Indoh, H. (1962).

This species is characterized by the presence of verticillate, straight branchlets of sporangiola, and sterile spines.

According to Hesselstine & Anderson (1957), *Ascophora pulchra* is a



figs. 1. a-f. *Helicostylum fresenii*. a. Columella of a terminal sporangium. b-d. Branchlets bearing sporangia and sterile spines. e. Detached sporangia. f. Sporangiospores.

synonym of *Chaetostylum fresenii* because the original description of Preuss is not sufficient and no illustrations are given. However, Upadhyay (1973) treated *Ascophora pulchra* as a valid species from the re-examination of Preuss's original material and referred *A. pulchra* to *Helicostylum pulchrum*

(Preuss) Pidoplichko et Milko. Because I have never seen the original description of Preuss nor examined the type material of *Ascophora pulchra*, I followed Lythgoe (1958) and referred the present isolates to *Helicostylum fresenii*.

Thamnidium Link ex Wallroth, Fl. Crypt. Germ. 2: 324 (1833).

Thamnidium Link, Mag. Naturf. Freund. Berlin 3: 31 (1809)—*Melidium* Eschweiler, D. Fructification Gen. Rhizomorphae Comm. 19 (1822)—*M.* Eschweiler ex Fries, Syst. Mycol. 3: 330 (1832).

Rhizoids and stolons absent. Sporangiphores arising from substrate mycelia, ending into sporangia or sporangiola, without sterile spines. Sporangia globose, without apophyses. Branchlets arising in whorls from sporangiphores, unbranched or several times branched dichotomously, ending into sporangiola. Sporangiola globose. Zygospores verrucose. Suspensors without appendages.

Type species: *Thamnidium elegans* Link ex Wallroth.

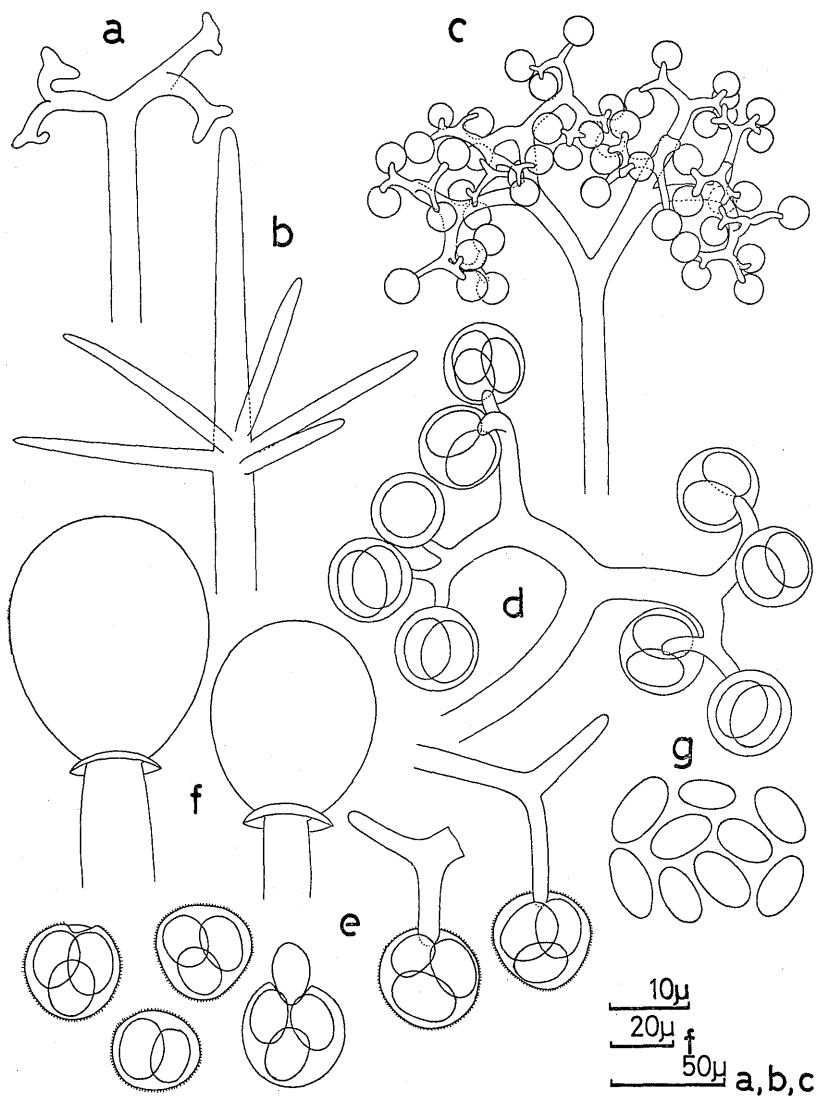
Three species have been known, in which only one species has been found in Japan.

Thamnidium elegans Link ex Wallroth, Fl. Crypt. Germ. 2: 324 (1833).

Thamnidium elegans Link, Mag. Naturf. Freund. Berlin 3: 31 (1809)—*Melidium subterraneum* Eschweiler, D. Fructification Gen. Rhizomorphae Comm. 33 (1822)—*M. subterraneum*, Eschweiler ex Fries, Syst. Mycol. 3: 331 (1832)—*Mucor elegans* (Link) Fries, ibid. 3: 322 (1832)—*Ascophora elegans* Corda, Icon. Fung. 3: 14 (1839)—*Melidium arbuscula* Otth, Mitth. naturf. Ges. Bern 172 (1865)—*Thamnidium vantieghemii* Berkerley et Broome, Ann. Mag. Nat. Hist. IV, 15: 40 (1875)—*T. arbuscula* (Otth) Saccardo, Syll. Fung. 14: 435 (1899)—*T. elegans* (Fries) Lind in Rostrup's Danish Fungi 73 (1913).

Illust.: Otani, Y. *et al.* 1951. figs. 2, a-g; fig. 4.

Colonies on LCA incubated at 20°C for a week light olive-gray to light brownish-gray, 1.5 cm high. Vegetative hyphae up to 36.9 μ m wide, hyaline. Gemmae not observed. Sporangiphores 7.7–30 μ m wide, hyaline, septate, unbranched or branched. Sporangia 25–130 μ m in diam, yellowish brown. Sporangial walls hyaline, minutely spiny. Columellae obovoid to pyriform, 25.4–96.2 μ m long, 23–81.5 μ m wide, hyaline, smooth, with a collar, constricted at the base. Branchlets of sporangiola at first non septate, later septate, sometimes adventitiously septate, slightly tapered towards the apex. Spo-



Figs. 2. a-g. *Thamnidium elegans*. a. Portion of a young sporangiophore bearing sporangia. b. Portion of a young sporangiophore bearing both sporangia and a terminal sporangium. c. Sporangiophore bearing sporangia. d. Terminal portion of branchlets having sporangia. e. Detached sporangia. f. Two columellae of terminal sporangia. g. Sporangiospores.

rangiola 12.3-21.5 μm in diam., yellowish-brown, with or without columellae. Sporangiole walls hyaline, roughened, persistent. Sporangiospores from sporangia and sporangiola ovoid to ellipsoid, 6.0-9.4 \times 4.7-5.6 μm , hyaline to pale yellow. Zygosporangia not observed.

Hab. and Loc. coll.: from rat dung, Nishiokoppe, Hokkaido (Mikawa-no. 539); rat dung, Sapporo, Hokkaido (Mikawa-no. 446); rat dung kindly collected by Miss Shizu Kuzuha in Yamagata Pref. (Mikawa-no. 298); horse dung, Honshu (Ito, S. 1936); air, Tokyo (Nakazawa, 1917); soil, Tottori Pref. (O-tani, Y. *et al.* 1951).

Zygosporangia have been found by some mycologists including Bainier (1884) and Hesseltine & Anderson (1956).

The present isolates agreed well with the description given by Hesseltine & Anderson (1956).

Thamnostylum von Arx et Upadhyay, in von Arx, The genera of fungi sporulating in pure culture, 247, (1970).

Rhizoids and stolons present. Sporangioles arising from substrate mycelia or stolons opposite the rhizoids, ending into a terminal sporangium or a sterile spine. Sporangia usually pyriform, apophysate. Branchlets of sporangiola arising singly or in cluster from nodes of main sporangioles, unbranched or branched, recurved. Sporangiola globose or pyriform. Zygosporangia verrucose. Suspensors lacking appendages.

Type species: *Thamnostylum pyriforme* (Bain.) von Arx et Upadhyay.

This genus is distinguished from *Helicostylum* by the presence of rhizoids and stolons and terminal sporangia with apophyses.

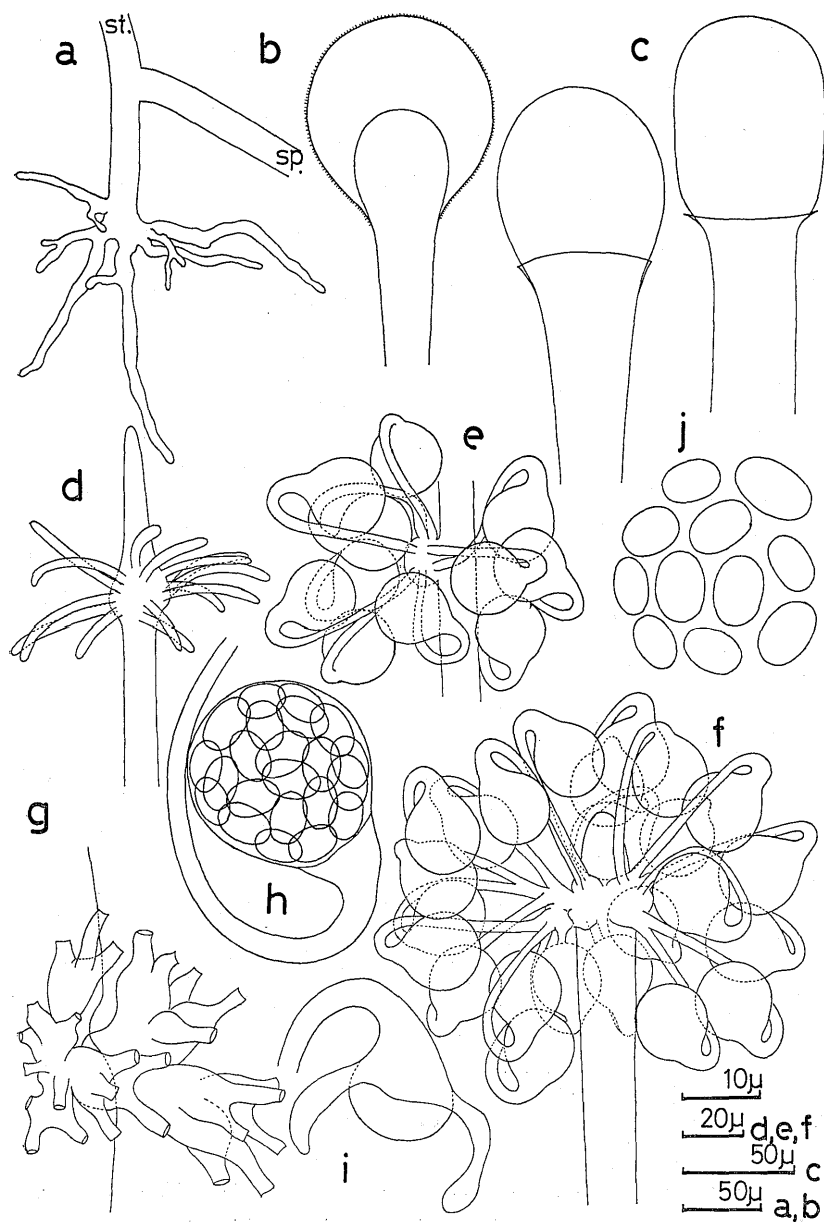
Four species have been hitherto known, in which following two species have been reported in Japan.

Key to species

1. Sporangiola globose *T. nigricans*
1. Sporangiola pyriform *T. pyriforme*

1) **Thamnostylum nigricans** (van Tieg.) Benny et Benjamin, Aliso 8: 312 (1975).

Helicostylum nigricans van Tieg., Ann. Sci. Nat. Bot. VI, 4: 374 (1876)
—*Thamnidium nigricans* (van Tieg.) Migula, Krypt.-Fl. Deutsch., Deutsch-



Österr., Schweiz 3: 207 (1910).

Hab. and Loc. coll.: from animal dung, Honshu (Ito, S. 1930 as *Helicostylum nigricans* van Tieg.).

I examined one strain (IFO 8091) which was identified as *H. nigricans* by Naganishi, but it agreed with the present isolates of *Thamnostylum piriforme* so far examined in the shape of sporangiola, branching of branchlets and other morphological features. This strain is probably misidentified.

2) ***Thamnostylum piriforme*** (Bain.) von Arx et Upadhyay, in von Arx, The genera of fungi sporulating in pure culture, 247, (1970).

Helicostylum piriforme Bain., Bull. Soc. Bot. Fr. 27: 277 (1880)—*Thamnidium piriforme* (Bain.) Migula, Krypt.-Fl. Deutsch., Deutsch-Österr., Schweiz 3: 207 (1910).

Illust.: Matsushima, T., 1975. Pl. 414, figs. 1-4; figs. 3, a-j.

Colonies on LCA incubated at 20°C for a week light olive-gray to dark olive-gray, 1.5 cm high. Vegetative hyphae hyaline, up to 55.4 μm wide. Stolons simple, olive-brown, non septate, rarely septate, with rhizoids, Sporangiphores hyaline at first, later becoming olive-brown above, usually non septate, rarely septate, 11.5-33.9 μm wide, unbranched or branched. Sporangia 100-150 μm in diam., dark brown. Sporangial walls hyaline, roughened. Columellae ovoid, obovoid, cylindrical or dome-shaped, 63-127.7 μm long, 56.2-88.5 μm wide, hyaline to pale brown, smooth, with a indistinct collar, apophysate. Branchlets of sporangiola hyaline, non septate, 3.1-4.1 μm wide, unbranched or dichotomously branched at the basal portions. Sporangiola pyriform, 19.3-36.2 μm in diam., pale yellowish-brown, with or without columellae, apophysate, Sporangiolar walls hyaline, smooth. Sporangiospores from sporangia and sporangiola oblong-ellipsoid, 7.5-11.3 \times 4.7-7.5 μm , hyaline to pale yellow. Zygosporos not observed.

Hab. and Loc. coll.: from rat dung, Takahagi, Ibaraki Pref. (Mikawa-no. 898); rat dung, Shinjuku, Tokyo (Mikawa-no. 109); rat dung, Itabashi, Tokyo (Mikawa-no. 209); rat dung, Mitsune, Hachijo Isl. (Mikawa-no. 455); rat

Figs. 3. a-j. *Thamnostylum piriforme*. a. Rhizoid and stolon having sporangiophore. (st.=stolon, sp.=sporangiophore) b. Terminal sporangium having a columella. c. Two columellae of terminal sporangia. d. Initials of branchlets. e. Branchlets of laterally formed sporangiola. f. Sporangiphore showing the arrangement of branchlets of sporangiola. g. Branchlets left after detachment of sporangiola. h. Detached sporangiolum. i. A columella of sporangiolum. j. Sporangiospores.

dung, Odomari, Sata Peninsula, Kagoshima Pref. (Mikawa-no. 232); forest soil, Funaura, Iriomote Isl. (Mikawa-no. 97); soil, kindly collected by Mr. Sueo Kato in Chichijima, Bonin Isls. (Mikawa-no. 944); cultivated soil, Nagano Pref. (Matsushima, T. 1975 as *Helicostylum piriforme* Bain.).

Zygospores have been found by some mycologists including Upadhyay (1973) and Benny & Benjamin (1975).

The present isolates agreed well with the Bainier's original description and also with that given by Upadhyay (1973) and Benny & Benjamin (1975).

This species is similar to *T. nigricans*, but is distinguished from the latter species by the presence of the pyriform sporangiola and fork-like branchlets of sporangiola.

References

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前回の報告 (本誌54巻3号, 1979) とあわせて, Thamniaceae に所属する5属7種を報告した。

Helicostylum は Corda (1842) の設立した属で, 現在までに約8種が知られている。近年, Upadhyay (1970, 1973) は仮根, 匍匐枝およびアポフィシスを有する孢子囊の存在を属の階級の特徴とみなして, Corda の *Helicostylum* を2分し, *H. elegans* を含む菌群を *Helicostylum* とし *H. piriforme* を含む菌群を *Thamnostylum* とした。近縁の科 Mucoraceae の分類系を考慮に入れると, Upadhyay の見解はより自然であると考えられるので, 本論文では彼の取扱いに従って分類した。